

Identification of priority areas for plant conservation in Madagascar using Red List criteria: rare and threatened Pandanaceae indicate sites in need of protection

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Appendix Malagasy Pandanaceae (6 species of *Martellidendron* and 85 species of *Pandanus*) with total number of subpopulations (determined from a 10 * 10 km grid, see text for details) and number in protected areas, extent of occurrence (EOO); see text for details; rounded to the nearest km if >2), area of occupancy (AOO; determined using the methods of Willis *et al.* (2000), Schatz *et al.* (2003), Schatz *et al.* (2000), and a 3 * 3 km grid cell; grid cell size for the method of Willis *et al.* is given rounded to the nearest km if >1; see text for details), predicted future decline (PFD, see text for details), Red List category and criteria (determined using EOO and AOO, the latter based on a 3 * 3 km grid with the addition of information from field observations; see text for details), distribution, and occurrence in protected areas.

| Species | No. of subpopulations | | AOO (km ²) | | PFD (%) ¹ | Red List category & criteria ² | Distribution | Protected areas |
|--|-----------------------|--------------------|------------------------|---|----------------------|---|-----------------------------|---------------------------------|
| | Total | In protected areas | EOO (km ²) | Willis <i>et al.</i> (grid cell size, km) | | | | |
| <i>Martellidendron androcephalanthos</i> (Martelli) Callm. & Chassot | 4 | 1 | 1,960 | 164 (6) | 67 | EN A3c; B1ab(i, ii)2ab(i, iii) | Sambirano lowland forests | Lokobe |
| <i>M. cruciatum</i> (Pic. Serm.) Callm. & Chassot | 6 | 2 | 101,410 | 68,694 (107) | 50 | VU A3c; B2ab(ii, iii) | E & Sambirano humid forests | Mananara-Nord, Manongarivo |
| <i>M. gallinarum</i> (Callm.) Callm. | 1 | 1 | | | 0 | VU D2 | E humid forests | Mananara-Nord |
| <i>M. karaka</i> (Martelli) Callm. | 4 | 1 | 717 | 245 (7) | 75 | EN A3c; B1ab(ii, iii)2ab(ii, iii) | E humid forests | Masoala |
| <i>M. kariangense</i> (Huynh) Callm. | 2 | 1 | | | 50 | EN A3c; B2ab(iii) | E humid forests | Mananara-Nord |
| <i>M. masoalense</i> (Laivao & Callm.) Callm. & Chassot | 5 | 3 | 7,135 | 2,646 (21) | 50 | EN A3c; B2ab(i, iii) | E humid forests | Masoala, Marojejy, Nosy Mangabe |
| <i>Pandanus ambongensis</i> Martelli | 11 | 0 | 129,308 | 50,625 (75) | 0 | VU B2ab(iii) | W deciduous forests | None |
| <i>P. acanthostylus</i> Martelli | 2 | 1 | | | 50 | EN A3c; B2ab(i, ii, iii) | E humid forests | Ranomafana |
| <i>P. alpestris</i> Martelli | 3 | 2 | 791 | 256 (8) | 33 | EN B1ab(iii)2ab(iii) | N mountains | Manongarivo, Tsaratanana |
| <i>P. alveolatus</i> Huynh | 2 | 1 | 111 | 48 (4) | 50 | EN A3c; B1ab(iii)2ab(iii) | N mountains | Anjanaribe-Sud, Marojejy |
| <i>P. ambalavaoensis</i> Huynh | 1 | 0 | | | 100 | CR A3c; B2ab(iii) | C highlands | None |
| <i>P. analamazaotrensis</i> Martelli | 2 | 1 | 24 | 4 (1) | 50 | EN A3c; B1ab(i, ii)2ab(i, iii) | E humid forests | Perinet |
| <i>P. analamerensis</i> Huynh | 8 | 1 | 24,441 | 800 (10) | 88 | VU A3c; B2ab(i, iii) | N dry forests | Analamera |
| <i>P. andringitrensis</i> Huynh | 3 | 2 | 3,032 | 300 (10) | 33 | EN B1ab(iii)2ab(iii) | E mountain forests | Andringitra, Ranomafana |
| <i>P. arenicola</i> Huynh | 2 | 2 | | | 100 | VU D1 | W deciduous forests | Zombitsy |

Appendix (Continued)

| Species | No. of subpopulations | | AOO (km ²) | | 3 km grid | PPD (%) ¹ | Red List category & criteria ² | Distribution | Protected areas |
|---|-----------------------|--------------------|---|----------------------|-----------|----------------------|---|---|-------------------------|
| | Total | In protected areas | Willis <i>et al.</i> (grid cell size, km) | Schatz <i>et al.</i> | | | | | |
| | | | | | | | | | |
| <i>P. aridus</i> St John | 6 | 2 | 19,482 | 800 | 81 | 33 | EN B2ab(i, iii) | Spiny bush | Andohahela, Zombitsy |
| <i>P. bakeri</i> Warb. | 3 | 0 | 191 | 300 | 36 | 0 | EN B1ab(iii)2ab(iii) | C highlands | None |
| <i>P. barbellatus</i> Huynh | 1 | 1 | 6 | 100 | 9 | 0 | VU D2 | Spiny bush | Andohahela |
| <i>P. biceps</i> B.C. Stone & Guillaumet | 2 | 2 | 6 | 100 | 27 | 0 | VU D1 | Eroded limestone of Ankarana massif | Ankarana |
| <i>P. bipyramidiatus</i> Martelli | 4 | 2 | 50,093 | 700 | 63 | 0 | VU B2ab(ii, iii) | E humid forests | Masoala, Marojejy |
| <i>P. calmandariana</i> Laivao & Buerki | 3 | 0 | 310 | 300 | 36 | 100 | CR A3; C2a(i) | Littoral forests | None |
| <i>P. cephalotus</i> B.C. Stone | 3 | 0 | 10,152 | 300 | 36 | 0 | VU B2ab(ii, iii) | Littoral forests | None |
| <i>P. ceratophorus</i> Baker | 4 | 1 | 7,033 | 400 | 45 | 75 | VU A3; B1ab(ii, iii)2ab(ii, iii) | E humid forests | Ranomafana |
| <i>P. columnaris</i> St John | 4 | 1 | 10,825 | 500 | 45 | 75 | VU A3; B1ab(iii)2ab(iii) | E humid forests | Masoala |
| <i>P. comatus</i> Martelli | 3 | 1 | 378 | 300 | 27 | 67 | EN A3; B1ab(i, ii)2ab(i, iii) | E humid forests | Masoala |
| <i>P. concretus</i> Baker <i>sensu lato</i> | 13 | 2 | 14,946 | 1,400 | 144 | 0 | VU B1ab(iii) | Littoral forests | Masoala |
| <i>P. connatus</i> St John | 1 | 1 | 3 | 100 | 18 | 0 | VU D1 | Littoral forests from Mananara to S of Vatomandry | Montagne d'Ambre |
| <i>P. coriaceus</i> Huynh | 5 | 1 | 9,988 | 700 | 72 | 87 | VU A3; B1ab(iii)2ab(iii) | N dry forests | Analamera |
| <i>P. dauphinensis</i> Martelli | 5 | 0 | 142 | 500 | 54 | 0 | EN B1ab(iii)2ab(iii) | Littoral forests around Fort-Dauphin | None |
| <i>P. diffusus</i> Martelli | 3 | 1 | 8,383 | 300 | 27 | 67 | VU A3; B1ab(i, ii, iii)2ab(i, ii, iii) | E humid forests | Mananara-Nord |
| <i>P. dyckioides</i> Baker | 9 | 3 | 48,004 | 1,200 | 144 | 67 | LC | E & C highlands' humid forests | Ambohitantely, Zahamena |
| <i>P. erectus</i> St John | 2 | 0 | 100 | 100 | 9 | 0 | DD | Littoral forests around the Baie d'Antongil | None |
| <i>P. flagellaris</i> B.C. Stone | 4 | 1 | 577 | 300 | 36 | 50 | EN A3; B1ab(i, ii, iii)2ab(i, ii, iii) | N dry forests | Analamera |
| <i>P. freycinetioides</i> (Gaudich.) Kurz | 3 | 0 | 17,958 | 400 | 45 | 100 | VU A3; B1ab(i, iii)2ab(i, iii) | E humid forests | None |
| <i>P. grallatus</i> B.C. Stone | 5 | 1 | 3,067 | 500 | 45 | 67 | EN A3; B1ab(i, ii, iii)2ab(i, ii, iii) | N dry forests | Analamera, Ankarana |

Appendix (Continued)

| Species | No. of subpopulations | | AOO (km ²) | | Schatz <i>et al.</i> | 3 km grid | PFD (%) ¹ | Red List category & criteria ² | Distribution | Protected areas |
|--|-----------------------|--------------------|---|------------------------|----------------------|-----------|----------------------|---|--|--------------------------------------|
| | Total | In protected areas | Willis <i>et al.</i> (grid cell size, km) | EOO (km ²) | | | | | | |
| <i>P. guillaumetii</i> B.C. Stone | 7 | 4 | 20,147 | 15,125 (55) | 1,000 | 90 | 36 | VU B2ab(iii) | E humid forests | Mananara-Nord, Masoala, Nosy Mangabe |
| <i>P. imerinensis</i> Martelli | 5 | 0 | 17,587 | 38,720 (88) | 500 | 45 | 0 | VU B1ab(iii)2ab(iii) | Littoral forest of the E coast | None |
| <i>P. insuetus</i> Huynh | 3 | 1 | 90 | 27 (3) | 300 | 27 | 67 | CR B1ab(i, iii) | E humid forests in the Masoala Peninsula | Masoala |
| <i>P. isalicus</i> Huynh | 7 | 2 | 19,760 | 3,200 (20) | 800 | 81 | 0 | VU B1ab(iii)2ab(iii) | W deciduous forests | Isalo |
| <i>P. kimlangii</i> Callm. & Laivao | 4 | 3 | 22,577 | 14,400 (60) | 400 | 54 | 25 | VU B2ab(ii, iii) | N & E humid forests | Manongarivo, Tsaratanana, Zahamena |
| <i>P. kuepferi</i> Callm., Wohlhauser & Laivao | 1 | 1 | | | 100 | 9 | 0 | VU D2 | N mountains | Tsaratanana |
| <i>P. latistigmaticus</i> Huynh | 3 | 2 | 307 | 192 (8) | 300 | 27 | 67 | EN A3c; B1ab(iii)2ab(iii) | Daraina forests & Montagne | Montagne d'Ambre |
| <i>P. leptopodus</i> Martelli | 10 | 4 | 19,905 | 35,287 (71) | 1,000 | 135 | 60 | VU A3c; B1ab(iii) | d'Ambre massif E humid forests | Masoala, Ranomafana, Zahamena |
| <i>P. linguiformis</i> B.C. Stone | 2 | 2 | 129 | 675 (15) | 200 | 18 | 0 | VU D1 | N mountains | Manongarivo, Marojejy |
| <i>P. longecuspis</i> Pic. Serm. | 4 | 3 | 3,794 | 1,024 (16) | 400 | 36 | 25 | VU B1ab(ii, iii)2ab(ii, iii) | E humid & mountain forests | Nosy Mangabe, Mananara-Nord, Masoala |
| <i>P. longipes</i> Perrier ex Martelli | 3 | 3 | 151 | 75 (5) | 300 | 27 | 0 | VU D1 | N mountains | Manongarivo, Tsaratanana |
| <i>P. longissimopedunculatus</i> Martelli | 5 | 2 | 20,588 | 14,580 (54) | 700 | 63 | 40 | VU A3c; B2ab(iii) | E humid forests | Zahamena |
| <i>P. longistylus</i> Martelli & Pic. Serm. | 2 | 0 | 430 | 578 (17) | 300 | 27 | 100 | EN A3c; B1ab(iii)2ab(iii) | Littoral forests of the SE | None |
| <i>P. macrophyllus</i> Martelli | 2 | 0 | | | 200 | 18 | 100 | CR A3c; C2a(i); D | E humid forests | None |
| <i>P. malgassicus</i> Pic. Serm. | 5 | 0 | 6,493 | 8,820 (42) | 700 | 72 | 100 | VU A3c; B1ab(i, ii, iii)2ab(i, ii, iii) | E Littoral forests | None |
| <i>P. mammillaris</i> Martelli & Pic. Serm. | 3 | 2 | 227 | 100 (5) | 300 | 36 | 33 | EN B1ab(iii)2ab(iii) | N mountains | Manongarivo, Tsaratanana |
| <i>P. mangokensis</i> Martelli | 5 | 3 | 8,761 | 18,000 (60) | 500 | 45 | 60 | VU A3c; B1ab(ii, iii)2ab(ii, iii) | E humid forests | Ranomafana, Zahamena |
| <i>P. manantoloensis</i> Huynh | 7 | 2 | 2,387 | 1,792 (16) | 700 | 63 | 29 | VU B1ab(ii, iii)2ab(ii, iii) | W deciduous forests | Bemaraha |
| <i>P. marojejicus</i> Callm. & Laivao | 1 | 1 | 0.4 | 0.18 (0.3) | 200 | 18 | 0 | VU D1 | N mountains | Marojejy |

Appendix (Continued)

| Species | No. of subpopulations | | AOO (km ²) | | Schatz <i>et al.</i> | 3 km grid | PFD (%) ¹ | Red List category & criteria ² | Distribution | Protected areas |
|---|-----------------------|--------------------|---|------------------------|----------------------|-----------|----------------------|---|--|----------------------------------|
| | Total | In protected areas | Willis <i>et al.</i> (grid cell size, km) | EOO (km ²) | | | | | | |
| <i>P. maromokotrensis</i> Callm. & Wohlhauser | 1 | 1 | 100 | 9 | 100 | 9 | 0 | VU D2 | N mountains | Tsaratana |
| <i>P. membranaceus</i> Huynh | 2 | 1 | 400 | 45 | 400 | 45 | 50 | EN A3c; B1ab(iii)2ab(iii) | W deciduous forests | Bemaraha |
| <i>P. microcephalus</i> Baker | 5 | 1 | 500 | 54 | 500 | 54 | 80 | VU B2ab(iii) | E humid forests | Zahamena |
| <i>P. myriocarpus</i> Baker | 2 | 1 | 200 | 18 | 200 | 18 | 0 | EN B2ab(iii) | Sambirano lowlands' forests | Tsaratana |
| <i>P. namakiensis</i> Martelli | 5 | 1 | 500 | 54 | 500 | 54 | 80 | VU A3c; B1ab(ii, iii) 2ab(ii, iii) | C highlands | Zahamena |
| <i>P. neoleptopus</i> Pic. Serm. | 3 | 0 | 400 | 36 | 400 | 36 | 100 | EN A3c; B1ab(i; ii, iii) 2ab(i, ii, iii) | Littoral forests | None |
| <i>P. sp. nov.</i> 'Inumbertii' ined. Laivao, Callm. & Buerki | 1 | 1 | 100 | 18 | 100 | 18 | 0 | VU D2 | N mountains | Marojeiy |
| <i>P. sp. nov.</i> 'neosemollii' Ined. | 1 | 0 | 100 | 9 | 100 | 9 | 100 | CR A3c; C2a(i); D | Galoka massif | None |
| <i>P. oligocarpus</i> Martelli | 4 | 1 | 400 | 45 | 400 | 45 | 75 | VU B1ab(iii)2ab(iii) | W deciduous forests | Bemaraha |
| <i>P. oligocephalus</i> Baker | 8 | 3 | 1,000 | 99 | 1,000 | 99 | 63 | LC | E humid forests | Masoala, Zahamena |
| <i>P. perrieri</i> Martelli | 2 | 0 | 200 | 18 | 200 | 18 | 100 | CR A3c; C2a(i); D2 | W & N forests | None |
| <i>P. pervilleanus</i> Solms | 14 | 3 | 1,900 | 198 | 1,900 | 198 | 84 | LC | E humid forests | Masoala |
| <i>P. petrosus</i> Martelli | 1 | 0 | 100 | 9 | 100 | 9 | 100 | DD | W deciduous forests (limestone of Kelyfely) | None |
| <i>P. pygmaeus</i> B.C. Stone & Guillaumet | 2 | 0 | 200 | 36 | 200 | 36 | 100 | CR A3c; C2a(i) | SE Littoral forests in swamps | None |
| <i>P. platyphyllus</i> Martelli | 4 | 0 | 500 | 45 | 500 | 45 | 0 | EN B1ab(iii)2ab(iii) | Littoral forest of the E coast in swamps | None |
| <i>P. pluriaculeatus</i> Huynh | 1 | 1 | 200 | 18 | 200 | 18 | 0 | VU D1 | N mountains | Manongarivo, Tsaratana |
| <i>P. princeps</i> B.C. Stone | 2 | 0 | 200 | 18 | 200 | 18 | 0 | CR B1ab(iii) | Littoral forest along streams (Baie d'Antongil, Masoala) | None |
| <i>P. pristinus</i> B.C. Stone | 2 | 1 | 200 | 27 | 200 | 27 | 50 | EN B1ab(iii)2ab(iii) | Eroded limestone of Ankarana massif | Ankarana |
| <i>P. pseudobathnici</i> Pic. Serm. | 4 | 3 | 500 | 45 | 500 | 45 | 40 | EN B1ab(iii)2ab(iii) | N mountains | Manongarivo, Marojeiy, Tsaratana |
| <i>P. pseudocollinus</i> Pic. Serm. | 4 | 0 | 400 | 36 | 400 | 36 | 100 | EN A3c; B2ab(i; ii, iii) | E lowland & Littoral forests | None |
| <i>P. pulcher</i> Martelli | 1 | 0 | 100 | 9 | 100 | 9 | 100 | DD | W deciduous forests | None |

Appendix (Continued)

| Species | No. of subpopulations | | AOO (km ²) | | Schatz <i>et al.</i> | 3 km grid | PFD (%) ¹ | Red List category & criteria ² | Distribution | Protected areas |
|--|-----------------------|--------------------|---|------------------------|----------------------|-----------|----------------------|---|--|--|
| | Total | In protected areas | Willis <i>et al.</i> (grid cell size, km) | EOO (km ²) | | | | | | |
| <i>P. pygmaeus</i> Thouars | 12 | 6 | 178,463 | 149,769 (129) | 1,300 | 126 | 54 | LC | E humid forests | Andohahela, Andringitra, Lokobe, Masoala |
| <i>P. rolloftii</i> Martelli | 7 | 1 | 17,039 | 69,112 (105) | 1,200 | 108 | 0 | VU B1ab(iii)2ab(iii) | Littoral forest of the E coast in swamps | Masoala |
| <i>P. sambiranensis</i> Martelli | 5 | 3 | 1,847 | 343 (7) | 700 | 63 | 40 | EN B1ab(i, iii)2ab(i, iii) | N mountains | Manongarivo, Tsaratanana |
| <i>P. saxatilis</i> Martelli | 5 | 3 | 1,160 | 216 (6) | 400 | 45 | 25 | EN B1ab(i, iii)2ab(i, iii) | N mountains | Manongarivo, Tsaratanana |
| <i>P. sparganioides</i> Baker | 1 | 1 | | | 100 | 9 | 0 | VU D1 | N mountains | Tsaratanana |
| <i>P. spicatus</i> St John | 1 | 1 | 1.5 | 0.27 (0.3) | 100 | 9 | 0 | VU D1 | Montagne d'Ambre massif | Montagne d'Ambre |
| <i>P. spinifer</i> Warb. | 3 | 2 | 1,791 | 507 (13) | 400 | 36 | 80 | EN A3c; B1ab(iii)2ab(iii) | C highlands | Ambohitantely |
| <i>P. stellatus</i> Martelli | 4 | 1 | 10,751 | 4,107 (37) | 400 | 36 | 71 | VU A3c; B1ab(iii)B2ab(iii) | W deciduous forests | Bemaraha |
| <i>P. stylicola</i> Huynh | 1 | 0 | 11 | 4 (1) | 100 | 9 | 100 | CR A3c; B1ab(i, ii, iii)2ab(i, ii, iii) | E Littoral forests | None |
| <i>P. tabellarius</i> Huynh | 1 | 1 | | | 100 | 9 | 0 | VU D2 | N mountains massifs | Marojezy |
| <i>P. tazooanii</i> Callm. & Wohlhauser | 1 | 1 | | | 100 | 9 | 0 | VU D2 | N mountains massifs | Tsaratanana |
| <i>P. tenuiflagellatus</i> Huynh | 3 | 1 | 2,387 | 432 (12) | 300 | 27 | 67 | EN A3c; B1ab(iii)2ab(iii) | W deciduous forests | Bemaraha |
| <i>P. tolanarensis</i> Huynh | 4 | 1 | 604 | 80 (4) | 500 | 45 | 75 | EN A3c; B1ab(iii)2ab(iii) | SE humid forests | Andohahela |
| <i>P. tsaratananensis</i> Martelli | 4 | 1 | 218 | 45 (3) | 400 | 45 | 75 | EN A3c; B1ab(iii)2ab(iii) | N mountains | Tsaratanana |
| <i>P. vandamii</i> Martelli & Pic. Serm. | 7 | 3 | 5,222 | 1,352 (13) | 800 | 90 | 63 | VU B1ab(iii) | Sambirano lowlands' forests | Lokobe, Manongarivo, Tsaratanana |
| <i>P. variabilis</i> Martelli | 1 | 0 | | | 100 | 9 | 0 | DD | W deciduous forests | None |

¹Predicted Future Decline²CR, Critically Endangered; EN, Endangered; VU, Vulnerable; DD, Data Deficient; LC, Least Concern. Descriptions of criteria (A, B, C and D and their subcriteria) are in IUCN (2001).